

Enabling energy sufficiency as a sustainable development concept in shrinking urban districts: the case of Wuppertal-Vohwinkel



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Summary

De-industrialization, climate and demographic changes are only a few key words that indicate the challenge of urban development in many industrialized countries for the coming decades. A fundamental transformation of infrastructure and the built environment is expected to adjust to future needs. Numerous concepts of integrating efficiency and renewable energy sources into urban planning were elaborated in recent years. Energy sufficiency in the meaning of voluntary demand reduction of energy intensive goods and services is the third and mostly forgotten pillar of sustainable development. However, organizational and spatial measures are needed to support behavior modification. This paper presents results of a transdisciplinary research design with local stakeholders and scientific experts to develop an understanding of what energy sufficiency might contribute to sustainable urban development. Based on the Multi-Level-Perspective of the transition research approach, it analyzes how stakeholders and experts define energy sufficiency structures for the shrinking district of Vohwinkel (Germany). The paper also shows a compilation and evaluation of measures which facilitate energy sufficient behavior in the fields of space heating and passenger transport on a local level. The methodological concept comprises expert interviews, thought experiments with stakeholders to develop a vision of an “energy sufficient Vohwinkel 2050” as well as a stakeholder workshop to discuss the results. A shrinking population is seen as a chance to actively adapt the built environment to foster energy sufficiency.

Keywords: energy sufficiency, sustainable urban transition, transdisciplinarity, long-term vision

1. Introduction

Urban development in many industrialized countries faces several challenges for the coming decades. Reducing greenhouse gas (GHG) emissions by 80 to 95% until 2050 compared to 1990 is one of the most demanding missions for these countries [1]. Cities are being recognized not only as key sites in the production of GHG emissions but also as especially vulnerable to the impacts of climate change (e.g. flooding, urban heat islands) [2]. Although it is not a new phenomenon, an increasing number of cities around the world will be confronted with de-industrialization, economic de-growth and a shrinking population [3]. A fundamental transformation of infrastructure and the built environment is thus expected to adjust to future

needs [4]. New kinds of systems in transport, energy and industrial production will arise which entail not only new technologies but also an alteration in user practice, cultural discourses, policies and governing institutions [5].

Theoretical considerations on sustainable development strategies discuss three fields of options: *Efficiency* is a course of action with which the input-output relation is improved (BETTER). Referring to energy use, a reduced amount of energy input is needed per unit good/service. Since it is a relative and not an absolute term, energy use can remain the same when efficiency improvements are offset by a raise in demand [6]. *Consistency* aims at qualitative changes in production and consumption by resource substitution, adaptation to renewable resources and a circular economy (DIFFERENT) [7]. *Sufficiency* in the meaning of voluntary demand reduction of energy intensive goods and services is the third and mostly forgotten pillar of sustainable development strategies. Sufficiency calls into consideration the absolute level of output or consumption per se and not in relation to the input [8]. Moreover, authors have argued that sufficiency as a concept also raises the question for levels of “enough” and helps to explore the potential of making it easier to live a *good life* (LESS/ENOUGH) [9]. As of now there is no common definition of sufficiency. This paper follows a pragmatic approach proposed by LINZ [10]. It draws attention to energy saving behavior in the management, purchase and using phase of energy intensive goods and services. It also allows defining indicators to measure sufficiency and helps different stakeholders to develop concrete measures at a local level. Because of the plurality of discussion, a definition of *energy sufficient behavior* is given in this paper with suggestions to operationalize sufficiency in two urban energy using sectors which account for a great share of energy demand: passenger transport and space heating in residential buildings.

Numerous concepts of integrating efficiency and renewable energy into sustainable urban development were elaborated in recent years. However, a growing number of studies on long-term mitigation potential of renewable energy resources and energy efficiency suggest that the goal of reducing GHG emissions will not be met without adaptation of energy demand behavior [11] [12]. They state that the inclusion of *high-hanging fruits* (costly and yet to be developed technologies) in the estimation of energy efficiency and renewable energy source potentials may lead to an overestimation of the potential to reduce GHG emissions and increases uncertainties.

The main aim of this paper is to conceptualize sufficiency as a strategy to enable sustainable urban transition based on the case study of Wuppertal-Vohwinkel. In the next chapter, the methodological approach is presented. Because little is known about the perception of local stakeholders, who represent a meso-perspective between the individual and the political sphere, a participatory research design is elaborated. Chapter 3 gives insights into the theoretical concept of the Multi-Level Perspective (MLP) to analyze and develop long term transitions. Moreover, a definition of energy sufficient behavior is given. Chapter 4 presents results of the stakeholder analysis (1), applies the MLP to the evaluation of Vohwinkel by stakeholders and experts (2) and gives an overview of measures to foster energy sufficiency in the fields of space heating and passenger transport (3). Chapter 5 discusses consequences of the findings followed by a conclusion in chapter 6 which also points out further research needs.

2. Methodology

The literature review in chapter 1 demonstrated the lack of transferring and applying the concept of sufficiency in the light of sustainable urban transition on an empirical case. There is little knowledge concerning the definition and measurement of sufficiency in local practice. That is the

reason why the following case study is based on an explorative, transdisciplinary and qualitative oriented research design.

Meeting the requirements of a transdisciplinary approach, stakeholders play a crucial role in the initial period of the research project. Several interlinked steps characterize this period: a formulation of the exact research objective was influenced by gathering background information on the reference area Vohwinkel and a literature analysis of the current state of research in sustainable urban transition and sufficiency. The selection of Vohwinkel took place in a focus group discussion as well as an on-site-inspection with representatives of the community and the local public utility company. Vohwinkel was chosen because of its predicted population loss of over 20% until 2050 and an ongoing de-industrialization. Explorative interviews with selected stakeholders, who are considered masterminds of innovative strategies for urban development by the community, were conducted to develop a first understanding of energy sufficiency on a local level and to choose fields of interest. The main phase of research process is divided into three data collection parts. First, 15 in-depth interviews with scientific experts were conducted to develop a concept of energy sufficiency as a strategy in urban sustainable transition. In an assessment phase energy sufficiency was further operationalized. Moreover, a first stakeholder analysis and a variety of measures to foster energy sufficient behavior were developed. Experts were selected due to their scientific publications in the field of urban planning as well as demand reduction in transport and space heating. Second, 15 face-to-face stakeholder interviews with thought experiments were conducted with local stakeholders to develop a long-term vision for an “energy sufficient Vohwinkel 2050”. Third, all stakeholders, who had participated in the interviews, were invited to a workshop in order to discuss the results.

3. Theoretical Considerations

The aim of this chapter is twofold: the first part explains the Multi-Level Perspective which guides the analytical part of the case study about Vohwinkel. It presents the main structure of the concept. In the second part, the understanding of sufficiency is reflected and operationalized in two urban sectors: passenger transport and space heating.

3.1 Sustainable urban transition and the Multi-Level-Perspective (MLP)

One manner to examine sustainable urban transitions lies in the socio-technical transition approach which focuses attention to processes, reasons and the management of fundamental structural transitions to a new system. In contrast to other theoretical approaches (e.g. policy cycle, complex system theory), the concept not only aims at describing and explaining transitions, but turns the attention to the management of currently ongoing transitions. One of the basic concepts of the transition research approach is the MLP. The concept provides us with a foil that helps to describe and inspect signs of future or ongoing transitions. This takes place in connection with an elaboration of courses of action and the questions of how and by which elements the development is affected [13].

According to the MLP, transitions occur due to developments on three different functional levels in which elements of these levels also interact with each other. On the level of the *socio-technical landscape* processes develop which can hardly be influenced directly by local stakeholders. This can be gradual changes in a long-term perspective like environmental changes and cultural alteration. These exogenous processes form the macro level and build up pressure for changes at the meso level [14]. The so-called *socio-technical regime* represents the meso level. Three dimensions shape and stabilize this level: firstly, the network of main stakeholders, secondly formal, normative and cognitive habits and thirdly material and technical elements [15]. A socio-

technical transition is characterized by a fundamental change in all dimensions until a stable regime leads to a new configuration of stakeholders, commonly agreed attitudes, rules and infrastructures. The *socio-technical niche* is located at the micro level where innovation and new structural configurations develop.

The aim of the case study is to shed light on aspects of the actual situation and ongoing developments in Vohwinkel that might form the basis for a sustainable urban transition. The concept also helps to generate an idea of how a sustainable Vohwinkel might evolve against the background of energy sufficient behavior.

3.2 Definition and Operationalization

This paragraph illustrates how energy sufficiency can be defined in the context of this study and how it can be operationalized. The pragmatic understanding of sufficiency in accordance with LINZ [10], which is primarily based on resource saving behavior in the management, purchase and using phase of goods and services, gives a starting point. It indicates that sufficiency is not restricted to the consumer behavior at an individual level which is expressed by an abandonment of certain accomplishments or modesty. The definition rather comprises all parts of economic, political and societal life which opens the view to aspects of urban development. More concretely, sufficiency deals hereinafter with the establishment of behavior which results in an absolute demand reduction of energy intensive goods and services. The emphasis on energy refers to the goal of GHG reduction of sustainable development. To put it in a nutshell, the understanding of sufficiency is not solely attached to the normative debate concerning behavioral disposition on an individual level but draws attention to structural conditions for alteration of behavior in a certain regional context. Energy sufficiency is expressed by a reduction of heating demand of households as well as avoidance of motorized passenger transport caused by behavior modification.

In the field of space heating, two approaches enable energy sufficient behavior:

- Reduction of the average room temperature measured in degree Celsius
- Reduction of heated floor space per person measured in square meter

In the field of passenger transport, two approaches can be distinguished as well:

- Reduction of trip length with motorized vehicles per person measured in kilometer
- Reduction of trip number with motorized vehicles per person

In both fields energy sufficient behavior can be examined on two levels of decision making which represent starting points for organizational and spatial measures. One starting point deals with decisions during the purchase, rental and investment phase (e.g. apartments, cars). These, only periodically made, decisions often determine energy use for a long period of time. Another starting point to influence energy sufficiency is looking at decisions during the using phase of building and transport infrastructure (e.g. choice of room temperature, choice of trip length and frequency). Daily changes are possible; however, routines might hamper adaptation.

To further specify sufficiency in practice, SACHS [16] generated the concept of the four E's (Enträmpeln, Entschleunigen, Entkommerzialisieren, Entflechten) which can be translated as the four Ds: downsizing, disentanglement, deceleration and de-commercialization. The four Ds serve as guidelines to analyze policies and practical actions for sufficiency.

Mirroring the theoretical considerations, *energy sufficient behavior* is defined in the context of this study as: *an absolute demand reduction of energy intensive services per person due to behavioral changes during the purchase, rental or investing phase as well as the utilization phase of goods and services.*

4. Results

The following chapter gives a compact overview of the stakeholder analysis and the vision of “an energy sufficient Vohwinkel 2050” by stakeholders. It analyzes how they rate their own role as well as the fields of action on the ground. Scientific experts complete the evaluation of framework conditions on the landscape level and help to identify the stakeholders.

Based on the expert interviews, seven key stakeholder groups were identified. Table 1 illustrates these groups by giving further details of particular members.

Table 1: Important stakeholders for fostering energy sufficiency on a local level

| Key stakeholder groups | Members |
|---------------------------------------|--|
| municipality | city planning department, local politicians (members of the city parliament, district representatives) |
| citizens | residents, consumers, users of infrastructure |
| non-governmental organizations (NGOs) | associations and clubs, religious communities, church organisations |
| local economy | traders, retailing, craftspeople, architects, energy consultants |
| real estate market | house owners, housing association, house owner associations, tenants associations |
| transport companies | public transport suppliers, car-sharing suppliers |
| locally known personalities | e.g. former mayors, presidents of sports clubs |

For about one half of the interviewees in Vohwinkel energy sufficiency is an unknown concept concerning sustainable urban development. The other half is well aware of energy sufficiency and claims that they try to integrate it in organizational and planning processes for quite a while. Especially non-governmental organizations, representatives of the municipality and transport companies are already keen on enabling the concept. However, they all express the wish to be able to be more involved in this direction. Structural and personal constraints (e.g. unwillingness of supervisors to engage in the topic) make it difficult for them. All interviewed stakeholders can imagine making an essential contribution to foster energy sufficiency in the future. Concerning their own role they see themselves as vision multipliers and guides due to their personal energy sufficient behavior. Moreover, they envision themselves as main actors providing awareness training and consulting services to transfer energy sufficiency in different aspects of everyday life. Another field of action which was particularly mentioned by the municipality (politicians and city planning) was setting an organizational and spatial framework to foster energy sufficiency.

The MLP concept provides a basis for the structured analysis of the current district development in Vohwinkel with respective framework conditions and future development potentials. According to the interviewees, the current regime is shaped by a variety of cultural, economical and infrastructural conditions that determine an unsustainable lifestyle and economy. These elements comprise a car-oriented transport and spatial planning culture in the city of Wuppertal, a continuous increase of living space per person and in absolute terms, an exacting demand of comfort and individualistic lifestyles as well as a disperse distribution of the shrinking population in the district. On the landscape level, several factors are identified which exert pressure for changing the system on the regime level. Experts and stakeholders mention a beginning re-evaluation of values to a non-materialistic way of living by social groups. Moreover, they mention

the recognition of climate change, a global financial crisis and increasing energy prices on the long run. Next to these external factors which can be hardly influenced by the local level, interviewees point out several factors which put the current way of living in Vohwinkel under pressure. These are a population decline in Vohwinkel, closing of social infrastructure and public bus routes, a fall in value of real-estate and an aging population with changing demands on the built development.

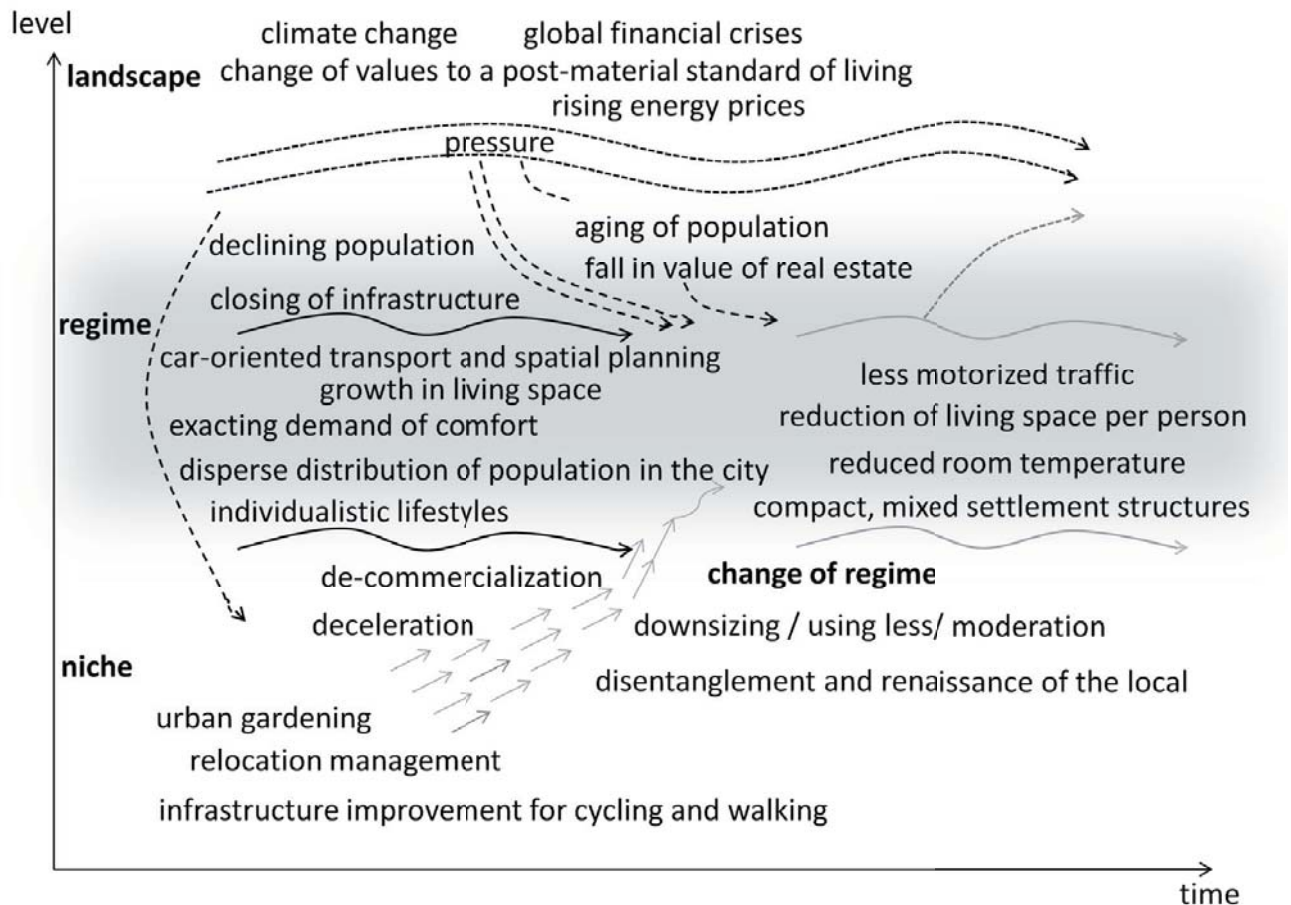


Figure 1: The MLP concept applied to Vohwinkel (own illustration based on GEELS [17])

The assessment also reveals the existence of several points on the niche level which can be seen as levers to fundamentally change the regime. These include on the one hand a broad stakeholder constellation, which can imagine supporting energy sufficiency in the future. On the other hand, stakeholders identified innovative measures to support a change in behavior. What those instruments might be and what effects they develop is shown in table 2 and 3 for the fields of space heating and passenger transport.

If new behavior patterns and infrastructural changes prevail, this will lead to a fundamental transition of the current way of living in Vohwinkel expressed by a decreasing demand of energy intensive goods and services. The new regime is defined by a demand reduction of motorized transport, less heated living space per person, a decreased room temperature as well as a compact and mixed settlement structures in Vohwinkel. The consulted stakeholders could well imagine that a variety of the proposed measures will be put into practice in Vohwinkel. However, they pointed out that a re-evaluation of current lifestyle choices is a prerequisite.

Table 2: Strategies and measures to foster energy sufficiency in the field of space heating

| Goal | Strategy | Measures | 4 Ds | Frequency of decision | Elements of change |
|--|--|---|---|-----------------------|--|
| more inhabitants per household | shared apartments, cross generational housing projects | information campaign, modification, new building | downsizing, using less and flexible use | periodically | organizational arrangements, urban structure, single building, information basis |
| less heated floor space per household | relocation when household size changes | relocation management, accommodation exchange | downsizing, using less | periodically | organizational arrangements, urban structure, |
| | variable floor plans | modification, new building | downsizing, flexible use | periodically | organizational arrangements, single building, information basis |
| | splitting large houses | modification, information campaign | downsizing, flexible use | periodically | organizational arrangements, single building, information basis |
| | smaller ϕ apartment size for new buildings | new building | downsizing, moderation | periodically | single building, information basis |
| | common rooms in apartment buildings (laundry, workshop) | information campaign, modification, new building | downsizing, de-commercialization | periodically | organizational arrangements |
| conscious heating and ventilation habits | distinction between day and night time in room temperature | information campaign, education, neighborly competition, technical assistance systems | downsizing, moderation | daily | organizational arrangements, information basis |
| | user specific selection of room temperature (living room, bedroom) | information campaign, education, neighborly competition, technical assistance systems | downsizing, moderation | daily | organizational arrangements, information basis |
| | shock ventilation | information campaign, education, neighborly competition | downsizing, moderation | daily | organizational arrangements, information basis |

Table 3: Strategies and measures to foster energy sufficiency in the field of passenger transport

| Strategy | Measures | 4 Ds | Frequency of decision | Elements of change |
|---|---|---|------------------------|---|
| maintaining of neighborhood supply | multi-purpose shops; pick up point for internet orders | disentanglement, renaissance of the local | daily | organizational arrangements |
| | decentralized kindergarten and schools | disentanglement, renaissance of the local | periodically | organizational arrangements |
| avoidance of mono-structured zones and preservation of local activity options | support of local clubs and civic engagement; youth center, sports facilities, urban gardening, attractive meeting sites, playgrounds | disentanglement, renaissance of the local; de-commercialization | daily | organizational arrangements, single building, information basis |
| | home office ; enabling of e-commerce and e-banking | disentanglement, renaissance of the local | periodically | organizational arrangements, information basis |
| compact urban forms | support of trip chains due to strategic location planning | disentanglement, downsizing | periodically | urban structure, single building |
| | shrinkage form the edges – contraction, demolition | downsizing, moderation | periodically | organizational arrangements, urban structure, single building |
| improvement of non-motorized transport; reduction of motorized transport | relocation management, accommodation exchange | disentanglement, downsizing | daily | urban structure, information basis |
| | enhancement of conditions for walking and cycling, increasing spatial resistance e.g. traffic calmed area /30 km/h area, parking space control: higher tariffs, less spaces | deceleration | daily | organizational arrangements, Urban structure |
| consulting services; campaigns to foster energy sufficient transport behavior | mobility management, competitions to save energy with transport component, car-free Sundays, highlighting energy sufficiency as children and age appropriate | deceleration, renaissance of the local | daily and periodically | information basis |

The category *frequency of decisions* in table 2 and 3 relates to the frequency with which citizens reach a point to change or determine their behaviour (daily/periodically). The category *elements of change* explains which kind of modification are initiated by the respective measure. Besides architectural and spatial (infrastructural) alterations, there are also *soft* factors like organizational arrangements and a change of the information basis. The category *4 Ds* refers to the four dimensions of characterizing sufficiency measures and policies (see chapter 3.2).

5. Discussion

The analysis of strategies to foster energy sufficiency has shown that most of the actual measures are neither radical new instruments nor technical solutions for a sustainable urban development. It is rather a modification of infrastructural conditions in the district (e.g. number and location of schools, shops and residential areas). Although stakeholders expressed their interest in energy sufficiency as one possibility to enable sustainable urban development it became also evident that some processes with regard to a shrinking population make it harder to behave energy sufficiently e.g. an increasing vacancy of apartments results in lower rental fees which might motivate for a larger floor size.

One benefit of looking at the local level to develop an idea of energy sufficiency represents the municipalities' discretion to act with regard to the design of settlements and transport structures. The choice of housing locations within the city determines important sufficiency parameter such as trip length, choice of modes of transport. Most trips start or end at home. An additional asset of the local level illustrates the fact that peer groups such as neighbors and friends serve as important point of orientation for changing behavior. Social acceptance and motivation can play a crucial role in rating energy sufficiency as a guiding principal for action.

The advantage of choosing a shrinking district as a case study can be seen in the fact that a declining population results in the need for infrastructural changes with regard to transport and spatial structure. That is why measures to enable energy sufficiency can contribute to an enhancement of otherwise challenged districts. In principle, most European cities bring a good basis for energy sufficiency oriented lifestyles due to the high concentration of buildings and people. However, a declining population and a lack of financial resources of municipalities might also challenge the realization of energy sufficient structures.

6. Conclusion

Finally, it should be stress that the municipal level emerges as a suitable starting point to enable energy sufficiency according to the case study. Stakeholders express their motivation to engage themselves more actively with energy sufficiency in combination with fostering energy efficiency and renewable energy sources at the urban level.

The Multi-Level-Perspective constitutes a valuable scheme to analyze the ongoing developments and to envision future pathways. However, a long-term vision of an energy sufficient Vohwinkel is straightforward and some measures are seen as desirable but not very likely to be implemented under current conditions. The paper gives a first idea for starting points to transform the fields of space heating and passenger transport to more energy sufficient systems. The continuing participation of stakeholders during the whole research process ensures an interaction with the concept and increases support for the idea of energy sufficiency.

There is a need for further research concerning implementation opportunities of the concept in practical application. The development of quantitative scenarios estimating the effects on

sustainable development goals such as GHG reduction potentials might enhance the discussion of energy sufficiency on the ground. Furthermore, the development and implementation of real-world laboratories can further reveal chances and problems of energy sufficiency.

7. References

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